and pressures demanded by gravity. The latter, on the other hand, as perpetually and continuously sets portions of the air in motion, in order to establish and maintain a state of equilibrium, which, however, is never attained, or rather we must clearly recognize that *the ceaseless complex changes in and motions of our atmosphere represent in fact the only state of equilibrium possible between gravity on the one hand and solar heating of the earth on the other.*

Seemingly with little regard for the considerations just mentioned, many have sought and still seek to ascribe terrestrial weather—that is to say, *all* the characteristic features of atmospheric variations—to *minor* features of solar activity, as, for example, to the spots and faculae of the sun or to its magnetic manifestations, or to the relatively small and irregular fluctuations in the intensity of its thermal radiations, or to some of these variously in combination, etc.

Even suppose these solar phenomena directly influence terrestrial weather in some way yet to be proved, is it not plainly most essential in detecting and analyzing cause and effect relations that we adequately segregate and make due allowance for the complex phenomena which clearly must result if solar insolation were perfectly constant and if the other manifestations of solar activity were entirely absent?

Those who have been most ready to find convincing evidence of definite relations between terrestrial weather and minor features of solar activity have seemingly disregarded the obligation devolving upon them to make the segregation, we have mentioned as necessary, between the major and the minor influences, or have tacitly inferred that such a result has been automatically attained merely as an indirect consequence of involved processes of combinations and analyses of data, quite, however, inadequate in themselves.

Variations in the intensity of thermal radiations from the sun must, of course, be reflected in terrestrial weather phenomena, but such reflected effects must stand in appropriate relation quantitatively to the variations themselves. The advocates of definite relations are generally too prone to follow a line of thought which, pushed to an issue, leads to the conclusion that "variations of terrestrial weather," "deviations from the average," or whatever unit or term may be employed to express weather features, are ascribable directly to solar variations. The fallacy or doubt of the correctness of such a view is brought out if we ask, would the "deviations," "variations," "departures," etc., be *nil* or nonexistent if the intensity of solar radiation were perfectly constant? We think this question can be answered only in the negative, which is very largely at least a refutation of many of the conclusions thus far advocated, or at least questions the quantitative correctness of such results.

Meteorologists must hail with approval the action of the astrophysical observatory of the Smithsonian Institution in establishing a permanent station for continuous observations of solar radiation at Calama, Chile, in South America, the objects and equipment of which are so well described by the director of the observatory, Dr. Charles G. Abbot, in the preceding note in the REVIEW. The collection of a prolonged series of nearly continuous measurements of solar radiation intensities, even from a single observatory, will supply meteorologists with much needed material for refining their studies of close relations between terrestrial weather and solar activity. It is greatly to be hoped that a few other like observatories may be established at distant points over the earth in order to bridge the inevitable gaps in the series of observations and to confirm and verify the general correctness of the results obtainable at a single station.

SOLAR AND SKY RADIATION MEASUREMENTS.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Weather Bureau, Washington, Mar. 1, 1919.]

INSTRUMENTS AND EXPOSURES.

In the REVIEW for January, 1916, 44:2, will be found descriptions of the exposures of the Marvin pyrheliometer at the various stations and an account of the methods of obtaining and reducing the radiation measurements. These still apply, except as amended in the REVIEW for January, 1917, 45:2. The increased amount of local smoke in the atmosphere at the American University, Washington, D. C., referred to in the REVIEW for January, 1918, 46:2, was eliminated with the discontinuance of the activities of the experiment station of the Chemical Warfare Service at the end of 1918.

On May 21 and June 14, 1918, respectively, the Marvin pyrheliometers of the spiral ribbon type in use at Lincoln, Nebr., and Madison, Wis., were replaced by Marvin silver block pyrheliometers. The factors for reducing the readings of these latter instruments to heat units were determined by comparison with simultaneous readings of Smithsonian silver disk pyrheliometer No. 1, the factors of the Marvin instruments having been first approximately determined by the electrical heating process described by Foote.[1]

In the REVIEW for January and April, 1916, 44:4, 179–180, will be found descriptions of the exposures of the Callendar recording pyrheliometer at the different stations and an account of the method by which these records are reduced to heat units. These still apply, except as modified in the REVIEW for January, 1917, 45:2.

The statements in the REVIEW for January, 1916 and 1917, 44:2 and 45:2, relative to skylight polarization measurements, and in the REVIEW for January, 1917, 45:2, relative to radiation normals and the extrapolation of pyrheliometric readings to air mass 1, also still apply.

OBSERVATIONS DURING JANUARY, 1919.

Table 1 is a summary of the measurements made at the different stations with the Marvin pyrheliometer. The departures from normal values indicate that direct solar radiation intensities were very close to normal at Madison, slightly below normal at Lincoln, and slightly above at Washington. A noon reading of 1.42 calories obtained at Washington on the 27th equals the highest January reading heretofore obtained at Washington.

No measurements were obtained at Santa Fe, N. Mex., on account of a defect in the galvanometer.

Table 3 shows close to normal radiation for the month at Washington, a deficiency at Madison during the second and third decades, and an excess at Lincoln during the first and second decades.

Skylight polarization measurements at Washington on five days give a mean of 55 per cent, with a maximum of 60 per cent on the 27th. These are below the average values for Washington. At Madison measurements on the last three days of the month, when the ground was bare of snow but ice covered Lake Mendota, give a mean of 58 per cent, with a maximum of 70 per cent on the 30th.

[1] See abstract in this REVIEW for November, 1918, 46: 499–500.

TABLE 1.—*Solar radiation intensities during January, 1919.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Jan. 4	(*1.41)	......	1.20	1.10	1.01	0.92	0.85	0.77	......	......
6	......	......	1.16	1.09	0.99	0.97	0.92	0.87	0.84	0.80
7	(*1.39)	......	......	1.06	0.96	0.87	0.80	0.73	0.68	......
10	......	......	1.34	1.28	......	......	......	......	......	......
13	......	......	1.19	1.00	......	......	......	......	......	......
16	(*1.35)	......	......	1.24	1.16	1.08	0.99	0.92	0.91	0.82
25	......	......	......	......	......	......	......	0.86	0.78	......
27	......	......	1.35	1.22	1.09	1.01	0.94	0.88	0.81	......
28	......	......	......	......	0.96	0.89	......	......	......	......
29	......	......	......	......	......	0.85	0.75	......	......	......
30	(*1.43)	......	1.24	1.16	1.07	1.00	0.91	0.85	0.80	0.74
31	......	......	1.32	1.22	1.15	1.09	1.03	0.98	......	......
Monthly means	......	......	**1.26**	**1.15**	**1.05**	**0.96**	**0.90**	**0.86**	**0.80**	**0.79**
Departures from 11-year normal	......	......	**+0.04**	**+0.05**	**+0.04**	**+0.02**	**+0.03**	**+0.05**	**+0.05**	**+0.08**
P. M.										
Jan. 4	......	......	......	1.16	1.05	0.96	0.87	0.79	......	......
8	......	......	1.17	1.09	1.00	0.96	0.88	0.82	0.76	......
13	......	......	......	1.09	1.01	0.94	0.80	......	......	......
27	......	......	......	1.27	1.12	1.03	0.94	0.85	......	......
30	......	......	1.19	1.06	0.97	0.89	0.81	0.74	0.68	......
31	......	......	1.28	1.19	0.98	0.93	0.88	0.83	0.79	0.75
Monthly means	......	......	**1.21**	**1.14**	**1.02**	**0.95**	**0.86**	**0.81**	**0.74**	**(0.75)**
Departures from 11-year normal	......	......	**−0.02**	**+0.02**	**−0.02**	**±0.00**	**−0.02**	**−0.01**	**−0.03**	**+0.01**

* Extrapolated, and reduced to mean solar distance.

Madison, Wisconsin.

Date.	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.										
Jan. 2	......	......	......	......	1.33	......	......	......	0.97	0.88
4	......	......	......	......	1.07	......	......	......	......	......
9	......	......	......	1.46	1.35	1.29	1.25	1.21	1.17	1.13
16	......	......	......	1.29	1.18	1.09	......	......	0.89	......
28	......	......	......	1.33	1.25	1.17	......	......	......	......
29	......	......	1.38	1.25	......	......	......	......	......	0.77
30	......	......	1.43	1.38	......	......	......	......	......	......
31	(*1.51)	......	1.38	......	1.24	1.16	1.08	1.01	0.94	0.89
Monthly means	......	......	**1.40**	**1.34**	**1.24**	**1.18**	**(1.16)**	**(1.11)**	**0.99**	**0.92**
Departures from 9-year normal	......	......	**+0.04**	**−0.01**	**−0.02**	**+0.01**	**+0.07**	**+0.10**	**+0.05**	**−0.02**
P. M.										
Jan. 9	......	......	......	1.47	......	......	......	......	......	......
25	......	......	......	1.25	1.20	1.18	......	......	......	......
28	......	......	......	1.31	1.27	1.11	......	......	......	......
29	......	......	......	1.31	1.11	......	......	......	......	......
31	......	......	......	1.30	1.26	......	......	......	......	......
Monthly means	......	......	......	**1.33**	**1.21**	**(1.14)**	......	......	......	......
Departure from 9-year normal	......	......	......	**+0.02**	**−0.02**	**−0.05**	......	......	......	......

* Extrapolated, and reduced to mean solar distance.

Lincoln, Nebraska.

Date.	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.										
Jan. 1	(*1.57)	......	......	1.35	1.26	1.19	1.11	......	......	......
2	......	......	......	1.40	1.32	1.27	1.20	1.17	1.13	1.08
3	(*1.53)	......	......	1.42	1.37	1.31	1.26	1.21	1.13	......
6	......	......	......	1.20	1.05	0.99	0.88	0.83	0.80	......
9	......	......	......	1.35	1.20	1.04	......	......	......	......
10	......	......	......	1.33	1.13	......	......	......	......	......
14	......	......	......	1.28	1.05	......	......	......	......	......
15	(*1.54)	......	......	1.28	1.15	1.05	0.99	0.93	0.87	......
29	......	......	1.37	1.28	0.96	0.92	0.88	......	......	......
30	......	......	1.14	......	1.05	......	......	......	......	......
31	......	......	1.28	1.19	1.15	1.06	......	......	......	......
Monthly means	......	......	**1.26**	**1.31**	**1.15**	**1.10**	**1.05**	**1.04**	**0.98**	**(1.08)**
Departures from 4-year normal	......	......	**−0.11**	**+0.01**	**−0.03**	**−0.02**	**−0.02**	**+0.03**	**+0.02**	**+0.11**
P. M.										
Jan. 1	......	......	......	1.36	1.17	1.14	1.17	1.12	......	......
6	......	......	......	1.25	......	......	......	......	......	......
10	(*1.54)	......	......	1.34	1.27	1.21	1.15	......	......	......
14	(*1.46)	......	......	1.28	1.22	1.16	1.10	1.04	0.99	0.94
15	......	......	......	1.29	1.22	1.12	......	1.01	0.96	......
29	......	......	......	1.27	......	......	......	......	......	......
30	......	......	......	......	......	0.99	0.92	......	0.77	......
31	......	......	1.27	1.12	1.04	0.96	0.88	......	0.76	......
Monthly means	......	......	**(1.27)**	**1.27**	**1.18**	**1.10**	**1.04**	**1.06**	**0.87**	**(0.94)**
Departures from 4-year normal	......	......	......	**−0.04**	**−0.05**	**−0.07**	**−0.06**	**±0.00**	**−0.13**	**−0.07**

* Extrapolated, and reduced to mean solar distance.

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.		
Dates.	8 a. m.	8 p. m.	Dates.	8 a. m.	8 p. m.	Dates.	8 a. m.	8 p. m.
1919.	mm.	mm.	1919.	mm.	mm.	1919.	mm.	mm.
Jan. 4	0.91	0.96	Jan. 2	0.79	0.48	Jan. 1	0.64	1.07
6	1.96	2.26	4	0.28	0.71	2	0.91	0.46
7	2.36	3.15	9	1.52	1.07	3	0.33	0.79
8	4.17	3.63	16	3.15	3.99	6	2.36	4.37
10	1.32	1.78	25	4.57	3.15	9	2.87	3.99
13	2.11	4.17	28	2.36	1.60	10	2.87	4.75
16	3.00	3.63	29	1.78	3.45	14	2.62	3.81
25	3.99	4.17	30	2.49	1.78	15	3.00	4.17
27	2.62	3.30	31	1.60	1.45	29	3.00	4.75
28	3.99	3.45	......	......	......	30	2.36	3.99
29	2.06	2.49	......	......	......	31	2.49	5.16
30	2.49	3.63	......	......	......	......	......	......
31	2.06	2.06						

TABLE 3.—*Daily totals and departures of solar and sky radiation during January, 1919.*

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals.			Departures from normal.			Excess or deficiency since first of month.		
	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.
	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Jan. 1	24	126	285	−136	− 15	99	−136	− 15	99
2	16	204	267	−145	62	79	−281	47	178
3	137	186	269	− 24	43	79	−305	90	257
4	240	170	145	78	25	− 47	−227	115	210
5	189	107	223	27	− 39	29	−200	76	239
6	228	140	256	65	− 8	60	−135	68	299
7	216	106	218	52	− 43	19	− 83	25	318
8	126	157	271	− 38	6	70	−121	31	388
9	135	213	252	− 30	61	49	−151	92	437
10	240	164	273	74	10	67	− 77	102	504
11	232	96	240	66	− 59	32	− 11	43	536
12	250	123	205	83	− 34	− 5	72	9	531
13	235	156	179	67	− 2	− 33	139	7	498
14	130	158	279	− 39	− 2	64	100	5	562
15	111	222	290	− 59	60	73	41	65	635
16	253	204	282	81	39	62	122	104	697
17	78	142	199	− 96	− 27	− 24	26	77	673
18	118	140	243	− 58	− 32	18	− 32	45	691
19	198	52	305	19	−124	77	− 13	− 79	768
20	209	77	79	28	−102	−152	15	−181	616
Decade departure							**92**	**−283**	**112**
21	217	100	50	34	− 83	−184	49	−264	432
22	70	37	70	−116	−149	−167	− 67	−413	265
23	31	108	212	−157	− 82	− 27	−224	−495	238
24	258	155	243	68	− 38	1	−156	−533	239
25	225	196	309	32	0	64	−124	−533	303
26	174	224	288	− 21	26	41	−145	−507	344
27	298	172	268	101	− 28	18	− 44	−535	362
28	185	230	284	− 15	28	31	− 50	−507	393
29	210	235	312	8	31	56	− 51	−476	449
30	300	243	316	96	36	57	45	−440	506
31	335	236	324	128	28	62	173	−412	568
Decade departure							**158**	**−231**	**−48**
Excess or deficiency since first of year, gr.-cal							**173**	**−412**	**568**
Excess or deficiency since first of year, per cent							**3.1**	**−7.8**	**6.3**

INFLUENCE OF THE SOLAR ECLIPSE OF JUNE 8, 1918, UPON RADIATION AND OTHER METEOROLOGICAL ELEMENTS.

By HERBERT H. KIMBALL, Professor of Meteorology, and S. P. FERGUSSON, Meteorologist.

[Dated: Weather Bureau, Washington, Mar. 4, 1919.]

INTRODUCTION.

The Weather Bureau program in connection with the solar eclipse of June 8, 1918, included measurements of both incoming and outgoing heat radiation at a station established for that purpose at Goldendale, Wash., observations of shadow bands at stations in or near the path of total solar obscuration, and observations of the usual meteorological elements at about 55 Weather Bureau stations within the zone of 90 per cent obscuration. While the preliminary arrangements were jointly